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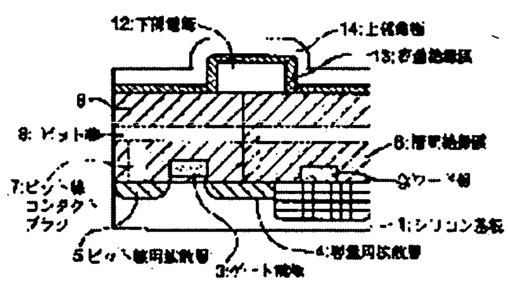
(54) MANUFACTURE OF SEMICONDUCTOR DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To reduce the characteristic deterioration of a capacitor element caused by heat treatment due to hydrogen gas, and to easily manufacture a semiconductor device with high reliability and productivity, when manufacturing the semiconductor device with the capacitor element where an STO (strontium titanate) film, a BST (barium titanate) film, a PZT (lead zirconium titanate) film, and a Y1 (strontium bismuth tantalum oxide) film are used as a capacity- insulating film or precious metal is used as a capacitance electrode.



SOLUTION: A semiconductor device is provided with a capacitor element which consists of a lower electrode 12, a capacity-insulating film 13 with a high dielectric constant, and an upper electrode 14. When the capacitor electrode is formed, the semiconductor device is heat-treated by a gas containing hydrogen, at least once before the capacitance-insulating film 13 is formed at the lower electrode 12 of the capacitor element.

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of a semiconductor device of having the capacitor component to which the manufacture approach of a semiconductor device is started, especially the high dielectric constant film or the strong dielectric constant film is used for a capacity insulator layer, and it uses noble metals for a capacity lower electrode.
[0002]
[Description of the Prior Art] Noble metals, such as a conductive oxide represented by Ru02 and Ir02, and the metal, platinum, in recent years as an electrode material of a capacitor component Moreover, strontium titanate film (henceforth the STO film) or barium titanate strontium film (It is hereafter called the BST film) etc. -- the dynamic random access memory (DRAM) to which the high dielectric constant ingredient was applied as a capacity insulator layer of a capacitor component -- Progress with remarkable micro device development, such as EFURAMU (FRAM) which applied strong dielectric constant film, such as the above-mentioned noble metals, titanic-acid zirconium lead (henceforth the PZT film), or strontium bismuth tantalum oxide (henceforth Y1 film), similarly, is shown. It is necessary to establish the noble metals mentioned above and the ultra-fine processing technology of a capacity insulator layer in manufacture of this micro device. Moreover, it must enable it to, take adjustment with the manufacturing technology of the existing semiconductor device on the other hand.
[0003] One of the existing techniques has heat treatment by hydrogen gas. This aims at operating a micro device to stability. That is, in order to control the interface-state-density consistency of the silicon which increased by passing through the production process of a semiconductor device, it is the approach of carrying out termination of the tangling pound of silicon by the hydrogen atom. After said heat treatment forms a transistor, a capacitor component, and aluminum wiring one after another, it is performed in the culmination of a production process.
[0004]
[Problem(s) to be Solved by the Invention] By the way, in the manufacture approach of the conventional semiconductor device, since there is a heat treatment process by hydrogen gas in the culmination of a production process, high dielectric constant ingredients, such as STO film, BST film, PZT film, and Y1 film, a strong dielectric constant ingredient, and a conductive oxide ingredient will receive a reduction operation of hydrogen gas. Here, fundamentally, since a high dielectric constant ingredient and a strong dielectric constant ingredient are oxides, many problems by reduction operation, such as membraneous degradation of a capacity insulator layer and an increment in leakage current, generate them. It is clear that Ir02 which is a conductive oxide similarly, and Ru02 also receive a reduction operation. Moreover, there is also a problem of a water molecule occurring in the interface of a conductive oxide and a capacity insulator layer, and also producing physical destruction of the capacity insulator layer by the pressure of a water molecule according to a reduction operation.
[0005] This invention is made in view of the situation explained above, and makes the STO film, the BST film, the PZT film, and Y1 film a capacity insulator layer. Moreover, when the semiconductor

device which has the capacitor component using noble metals as a capacity electrode manufactures, Property degradation of the capacitor component which heat treatment by hydrogen gas causes is reduced, and it aims at offering the manufacture approach of a semiconductor device that it is the basis of high dependability and productivity, and a semiconductor device can be manufactured easily.

[0006]

[Means for Solving the Problem] Invention concerning claim 1 makes a summary the manufacture approach of the semiconductor device characterized by heat-treating a semiconductor device by the gas containing hydrogen once [at least] or more in the manufacture approach of a semiconductor device of having the capacitor component which used the high dielectric constant film or the strong dielectric constant film, before the process which forms said high dielectric constant film in the lower electrode of a capacitor component.

[0007] Invention concerning claim 2 makes a summary the manufacture approach of the semiconductor device according to claim 1 characterized by the above-mentioned quantity dielectric constant film being the strontium titanate film, the barium titanate strontium film, and film that consisted of at least one kind chosen from the group which it becomes from tantalum oxide.

[0008] Invention concerning claim 3 makes a summary the manufacture approach of the semiconductor device according to claim 1 characterized by the above-mentioned strong dielectric constant film being titanic-acid zirconium **** and film which consisted of at least one kind chosen from the group which it becomes from strontium bismuth tantalum oxide.

[0009] Invention concerning claim 4 makes a summary the manufacture approach of the semiconductor device according to claim 1 characterized by being the film which consisted of at least one kind chosen from the group which the lower electrode of the above-mentioned capacitor component becomes from a diacid-ized ruthenium, a ruthenium, diacid-ized iridium, iridium, and platinum.

[0010] Since according to this invention heat treatment by hydrogen gas aiming at operational stability of a transistor is beforehand performed before forming capacity insulator layers, such as STO film, BST film, PZT film, and Y1 film, on a capacity lower electrode, said capacity insulator layer does not receive a reduction operation theoretically. Moreover, since a dielectric etc. does not change even if the capacity electrode which consists of a conductive oxide receives a reduction operation, a role of a capacity electrode is played enough. Moreover, since the water molecule produced in the reduction operation is desorbed from on an electrode surface, it does not have direct effect on a capacity insulator layer.

[0011]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. Drawing 1 is the sectional view showing the configuration of the semiconductor device manufactured by the manufacture approach concerning 1 operation gestalt of this invention. With this operation gestalt, LOCOS (Local 0xidation of Silicon) etc. forms first the field oxide 2 which is a non-active region on a silicon substrate 1 by the usual isolation approach, and the component active region enclosed by them is formed.

[0012] Next, the MOS transistor which consists of the gate electrode 3 through gate oxide, a diffusion layer 4 for capacity, and diffusion layer 5 grade for bit lines is formed on a component active region. This MOS transistor turns into a transfer transistor of a memory cell. Moreover, a word line 9 is formed on field oxide 2. This word line 9 is connected to the gate electrode (illustration abbreviation) of the transfer transistor of a contiguity memory cell. And an interlayer insulation film 6 is formed so that this gate electrode 3 and word line 9 may be covered. here -- chemical vapor deposition (CVD) with a well-known interlayer insulation film 6 -- it is the silicon oxide by law.

[0013] Next, on the diffusion layer 5 for bit lines of the above-mentioned MOS transistor, opening of the contact hole is carried out, conductive ingredients, such as a tungsten, titanium nitride, and tungsten silicide, are laid under this contact hole, and the bit line contact plug 7 is formed. And after depositing conductor film, such as a tungsten, patterning is carried out according to known lithography and a known dry cleaning dirty process, and a bit line 8 is formed.

[0014] next -- as the interlayer insulation film 6 which covers a bit line 8 -- again -- silicon oxide -- a CVD method -- forming membranes -- chemical mechanical polishing (CMP) -- flattening is carried out

by law. And it is filled up with the polish recon which contains a phosphorus impurity in this contact hole, while carrying out opening of the interlayer insulation film on the capacity diffusion layer 4 and forming a contact hole. Thus, the capacity contact plug 20 is formed.
[0015] Next, by the spatter using direct-current magnetron discharge, the ruthenium (Ru) metal of 99.9% of purity is targeted, and the ruthenium oxide film 10 is formed to 400nm thickness using oxygen and the mixed gas of argon gas. And 200nm spreading membrane formation of the SOG (Spin on Glass) film which consists of an organic silica used as an etching mask is carried out, patterning is carried out according to known lithography and a known dry cleaning dirty process, and the SOG mask 11 is formed.
[0016] Next, the ruthenium oxide film 10 is etched on condition that anisotropic etching using the dry etching system using the plasma discharge (ECR) by the electron cyclotron resonance. Here, the gas used for etching is the mixed gas of chlorine and oxygen. With this operation gestalt, chlorine gas was adjusted to about 5 - 50%, and the quantity of gas flow was set to 240sccm(s). The etch rate of the ruthenium oxide film obtained at this time turned into 250 nm/min extent. Then, the lower electrode 12 is formed by removing the SOG mask 11 which became unnecessary using the known etchback method (refer to drawing 2).
[0017] Next, heat treatment using the hydrogen of nitrogen gas dilution is performed. A heat treating furnace is ordinary pressure, processing temperature is made into 400 degrees C or more, and the processing time is made into 40 minutes or more. By performing this heat treatment, it is returned completely and the lower electrode 12 which consists of a ruthenium oxide film changes to a ruthenium metal.
[0018] Next, the capacity insulator layer 13 is formed so that the front face of the lower electrode 12 may be covered. Here, this capacity insulator layer 13 is BST film with a thickness of 50nm deposited by the plasma-CVD method. The specific inductive capacity of this BST film is about 500. Then, the ruthenium of 200nm of thickness is formed as an up electrode 14.
[0019] Thus, the diffusion layer 4 for capacity used as the gate electrode 3 of a transfer transistor and source drain field which constitute a memory cell, the diffusion layer 5 for bit lines, the lower electrode 12 that carries out electrical connection to the diffusion layer 4 for capacity through the capacity contact plug 7, and turns into an information storage electrode further, and the bit line 8 which carries out electrical connection to the diffusion layer 5 for bit lines through the bit line contact plug 7 are formed in active regions other than field oxide 2 of silicon substrate 1 front face. And the capacitor of a stack mold is constituted with the up electrode 14 and the capacity insulator layer 13 which are the counterelectrode of an information storage electrode.
[0020] According to this operation gestalt, since heat treatment using hydrogen is performed before it forms a capacity insulator layer, a capacity insulator layer is not returned, therefore it does not have degradation of capacitance characteristics, either.
[0021] Drawing 4 is drawing which compared the current-voltage characteristic of the capacitor which performed heat treatment by hydrogen before capacity insulator layer formation according to this operation gestalt, and the capacitor which heat-treated after the conventional capacity insulator layer formation. As shown in this drawing, leakage current was able to be controlled by heat-treating before capacity insulator layer formation.
[0022] In addition, the configuration of the above-mentioned operation gestalt is mere instantiation, and was chosen as an example from the ingredients which also enumerated ingredients, such as strong dielectric constant film, to the claim. The manufacture approach of this invention of including the manufacture approach of a semiconductor device of having added various corrections and modification, from the configuration of the above-mentioned operation gestalt is natural.
[0023]
[Effect of the Invention] In order to perform heat treatment by hydrogen gas according to this invention before forming a capacity insulator layer as explained above, in case the semiconductor device which contains the capacitor component using noble metals as a capacity electrode by making the STO film, the BST film, the PZT film, and Y1 film into a capacity insulator layer is manufactured, property

degradation of a capacitor component can be avoided, the yield of a semiconductor device improves, and it is effective in the ability to raise productivity.

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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The manufacture approach of the semiconductor device characterized by heat-treating a semiconductor device by the gas containing hydrogen once [at least] or more before the process which forms said high dielectric constant film in the lower electrode of a capacitor component in the manufacture approach of a semiconductor device of having a capacitor component using the high dielectric constant film or the strong dielectric constant film.
[Claim 2] The manufacture approach of the semiconductor device according to claim 1 characterized by the above-mentioned quantity dielectric constant film being the strontium titanate film, the barium titanate strontium film, and film that consisted of at least one kind chosen from the group which it becomes from tantalum oxide.
[Claim 3] The manufacture approach of the semiconductor device according to claim 1 characterized by the above-mentioned strong dielectric constant film being titanic-acid zirconium **** and film which consisted of at least one kind chosen from the group which it becomes from strontium bismuth tantalum oxide.
[Claim 4] The manufacture approach of the semiconductor device according to claim 1 characterized by being the film which consisted of at least one kind chosen from the group which the lower electrode of the above-mentioned capacitor component becomes from a diacid-ized ruthenium, a ruthenium, diacid-ized iridium, iridium, and platinum.

[Translation done.]

* NOTICES *

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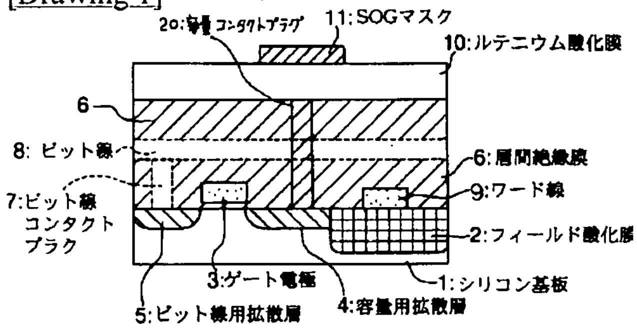
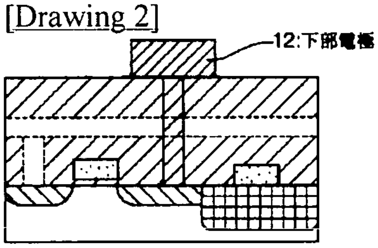
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

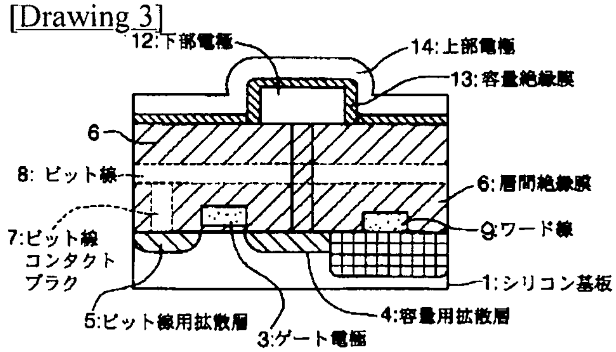
[Drawing 1]



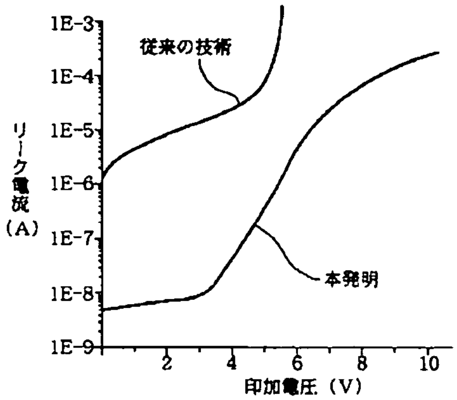
[Drawing 2]



[Drawing 3]



[Drawing 4]



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